EARTHQUAKE ENGINEERING AND STRUCTURAL DYNAMICS, VOL. 26, 667–668 (1997)

BOOK REVIEW

FINITE-ELEMENT MODELING OF UNBOUNDED MEDIA by John P. Wolf and Chongmin Song Wiley, New York 1996

This interesting book on dynamic soil–structure interaction is Wolf's fourth major work on the subject. As was the case with his previous treatises, this new volume has much to offer to specialists in elastodynamics, and it includes some truly innovative techniques for the treatment of unbounded domains, including structures of large, even if not infinite dimensions. Typical examples of application of these techniques are constructions on (or near) the surface of the earth subjected to seismic waves. Perhaps the most remarkable aspect of the methodology proposed by the authors is that it is based entirely on finite element concepts, and does not rely at all on the use of the abstruse boundary elements normally required for such problems. This allows the authors to formulate appropriate dynamic boundary conditions for media in which the material properties may change arbitrarily in directions parallel to the boundary, while at the same time preserve the mechanical radiation characteristics into the infinite medium. In addition, the boundary need not follow a plane, spherical or cylindrical contour, as is required in classical methods, but can follow an irregular path. When combined with conventional finite elements to model the "soil island" or "interior region" contained by the transmitting boundary, this powerful technique allows one to study, at least in principle, the dynamic behaviour of infinite media having arbitrary shapes and/or material constitutions.

The book has 14 chapters grouped into an Introduction followed by three parts, and it includes an appendix with benchmark examples. It also contains a brief References section with a scanty 72 entries which, despite a voluminous literature available on the subject of transmitting boundaries and unbounded media, refer mostly to works by the senior author and that of his associates.

The first part deals with what is perhaps the most interesting and original aspect of the book, namely the *Consistent Infinitesimal Finite-Element Cell Method*; the nine chapters in this section present the essential aspects of this new method for modelling infinite media. The formulation is presented not only in the usual frequency domain, but in the time domain as well, so that it is also possible to address problems in which the interior of the soil island undergoes inelastic deformations.

The second part, with two chapters, is devoted to the *Damping Solvent Extraction Method*, which allows simulating unbounded media by means of bounded domains via finite elements that include fictitious damping, which is later removed. This method finds its justification in a theory first described by Dasgupta and Sackman,[1] who related the dynamic solution for an arbitrarily damped medium to the corresponding solution for the undamped medium through an integral transform. Also, an essentially identical, but reversed method was presented by the writer[2] and by Pais and Kausel,[3] the main goal of which was to obtain damped solutions for foundation impedances directly from available, undamped ones.

Finally, the last two chapters in the third part are concerned with an application of the Doubly Asymptotic Multi-directional Transmitting Boundary, based on an algorithm first proposed by Mathhews and Geers.[4] In the authors' view this approximate boundary offers superior performance when compared to other schemes. However, the jury is still out on this issue; a closer look reveals that the local curvature of the boundary ought to be considered when deriving the characteristic equations of the paraxial and viscous boundaries, and that this curvature plays a role in their performance. For plane boundaries, on the other hand, Maeda and Kausel[5] found the performance of the doubly asymptotic boundary to be less satisfactory than that of paraxial boundaries.

More than a textbook, this volume resembles a massive technical paper. Nonetheless, it is destined to become an essential reference to researchers dealing with numerical models for the solution of problems in dynamic soil–structure interaction. It is clearly organized and well written, so that the basic ideas can readily be grasped with even a cursory reading. The reader should be prepared for some serious study, however, if the ultimate goal is to acquire command of the material to the point where the proposed techniques can be put to actual use. On the one hand, the authors' choice to represent matrices with brackets and curly braces surrounded by sub-and super-indices rather than with more transparent boldface symbols detracts somewhat from the readability of the equations, and may slow down mastery of the low-level details in the formulation. On the other, the solution relies on the development of very recent matrix methods, such as numerical solution of the algebraic Ricatti equation, which are neither part of standard textbooks on linear algebra, nor may the requisite references be readily available to all readers. Therefore, an appendix describing the essential aspects of these ancillary matrix methods would have been desirable.

CCC 0098–8847/97/060667–02$17·50

A detailed user's manual with examples and the source code (in FORTRAN 77) for the methods presented in the book are available, for free, from the publisher.

REFERENCES

1. G. Dasgupta, and J. L. Sackman, 'An alternative representation of the elastic–viscoelastic correspondence principle for harmonic motion', *J. appl. mech.* 57–60 (1997).
2. E. Kausel and J. P. Wolf, 'Vibrations of Foundations', *Workshop on Soil–Structure Interaction held at the Computational Mechanics Centre* (currently the Wessex Institute of Technology), Southampton, England, 1984.
3. A. Pais and E. Kausel, 'Stochastic response of foundations', *MIT Research Report R85-6* (February), Department of Civil Engineering, Cambridge, MA 02139, pp. 33–34.
4. I. C. Mathews and T. L. Geers, 'A doubly asymptotic, nonreflecting boundary for ground shock analysis', *J. appl. mech.* **54**, 489–497 (1987).
5. T. Maeda and E. Kausel, 'On the accuracy of some anti-plane halfspace stiffnesses', *Bull. seism. soc. Amer.* **81**, 1340–1359 (1991).

EDUARDO KAUSEL
Department of Civil and Environmental Engineering
Massachusetts Institute of Technology, Cambridge
MA, U.S.A.